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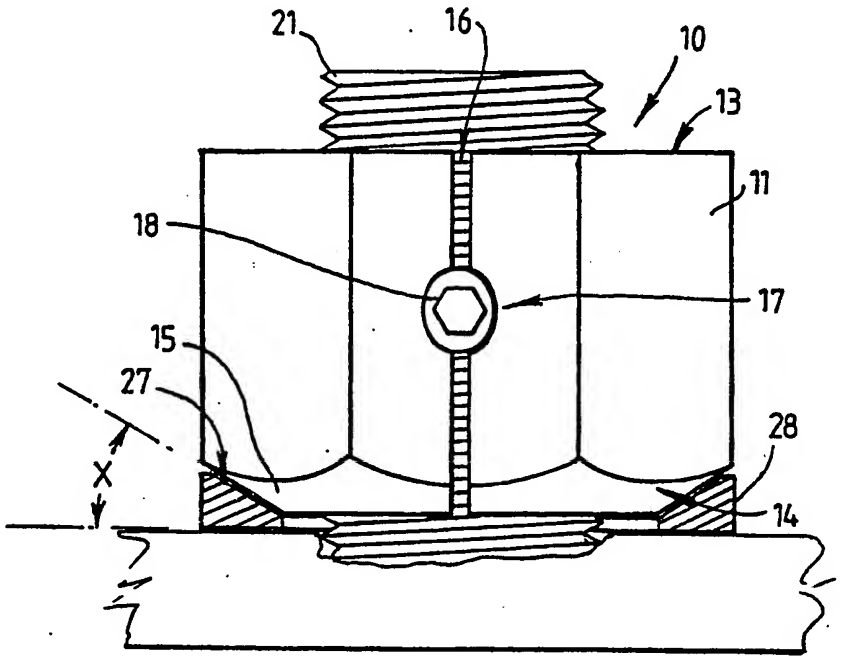


(57) Abstract

A self-locking nut comprising an annular body (11) having a screw threaded interior passage (12). A slit (16) extends from the interior passage through to the outer side of the annular body and extends axially from a first end (13) to a second end (14) of the annular body (11). An expansion element (18) is retained in a recess (17) located in the annular body (11) and intersecting the slit (16). The expansion element is rotatable between first and second positions and is asymmetrically shaped such that movement of the expansion element (18) from the second position to the first position causes the slit to open thereby increasing the diameter of the interior passage (12), so that the nut ceases to be a stiff nut and becomes freely rotatable on the intended bolt.

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# IMPROVED SELF LOCKING NUT

## TECHNICAL FIELD

The present invention relates to a self-locking nut, by which is meant a nut which is inherently highly resistant to loosening under vibration forces. Nuts of this type are sometimes known as "stiffnuts".

## BACKGROUND ART

Previously, various devices have been proposed for preventing or resisting the loosening of a nut on a screw, bolt or other threaded member such as a stud when subject to vibrations. Stiffnuts have certain conveniences over positive locking devices but do have certain limitations and disadvantages.

One such self locking nut disclosed in UK Patent No. 19069 to Havenhand consists of a conventional nut which was formed with a slit down one of its faces extending into the bolt hole. The slit in the nut was then closed under pressure reducing the diameter of the nut thread and the nut was then hardened and tempered so as to be ready for engagement with a bolt or stud. This nut, although being an effective self locking nut by virtue of the inherent clamping forces between nut and bolt threads has the disadvantage of having a high application resistance as the nut had to be wound down the bolt thread in the clamped position. Furthermore, when subjected to the immense forces applied to the nut when being preloaded by impact wrenches the split tended to open as the tension increased.

An earlier development in lock nuts disclosed in US Patent No. 193272 was similar to the above described nut with the addition of a wedge which could be inserted into the slit thereby opening the nut so that it could readily be wound down the bolt thread by hand and when in position, the wedge could be withdrawn to permit the nut to close around the bolt thread.

The latter arrangement however has a number of disadvantages due to the fact that the wedge cannot be forced radially into the central portion of the slit in the

nut due to possible thread damage and the fine angle required of the wedge and accordingly the wedge is required to be forced axially or longitudinally into the top of the slit. As the wedge is required to pass down parallel to the thread, however, again thread damage can often result due to the wedge being off course.

Furthermore, as the width of the slit varies from the smaller sizes of nuts to the largest sizes, different sized wedges for different sizes of nuts are required. In addition, the wedge is required to be of a predetermined penetration length to avoid the slit in the nut being expanded beyond its point of recovery. Should the nut pass this point of expansion, it will not fully recover and thereby lose some of its locking characteristics.

Further disadvantages arise because the wedge operates in a parallel sided slit so that the inner edge of the slit takes all the wear as soon as the nut commences to expand. These very large forces over such a small area wear the top of the slit and after a number of uses the wedge needs to penetrate further to open the slit to allow for the nut to be freely wound down the bolt thread.

A further quite serious disadvantage is that the wedge, when opening the slit opens it only at one end and closes it at the other end thereby requiring the slit to be opened further to overcome the misalignment of the nut and bolt threads.

A further disadvantage is that non-standard tools are required to open the nut for use.

DISCLOSURE OF THE INVENTION

The present invention aims to ameliorate at least some of the disadvantages of the prior art by providing a nut comprising an annular body having first and second ends extending around an axis with a screw-threaded interior passage extending along said axis, a slit extending outwardly from the interior passage to the outer side of the annular body and extending axially from the first end to the

second end, the nut being of resiliently expandable form for fitting to an intended bolt and being arranged to be biased by the resilient material from which the nut is made into a normal position wherein the interior passage has a significantly reduced diameter compared with the diameter of the intended bolt such that when fitted on the bolt, the nut has a high resistance to rotation, an expansion element being retained in the annular body and being rotatable between a first position wherein the expansion element causes the slit to open against the inherent resilience of the nut to permit the nut to be freely threaded onto the bolt, and a second position wherein the expansion element allows the slit to close under the influence of the inherent resilience of the nut towards or to the normal position such that the nut, when located on the bolt, is caused to clamp tightly on the bolt.

Preferably, the expansion element has means for engagement with a removable tool to facilitate movement of the expansion element between the first and second positions.

Preferably, the expansion element is wholly retained in a recess formed in the body of the nut. Preferably this recess is located midway between the first and second ends of the annular body.

Preferably, the expansion element is rotatable around a rotation axis extending at right angles to the axis of the threaded interior passage and in a cross section at right angles to this rotation axis, the expansion element is substantially oval in shape. It must be appreciated that the expansion element, in a cross section perpendicular to the rotation axis, may be of any other suitable non-circular form.

The expansion element, in cross section through the rotation axis, in one embodiment can be barrel like in shape and the expansion element is arranged to be inserted into the recess by a snap fit process so as to be retained.

However, for ecomony of manufacture, the expansion element may be parallel sided. In this arrangement, the

recess may be arranged with similar parallel sides and sized such that the expansion element is merely slotted into the recess in the second position without needing to expand the slit. To retain the expansion element in the recess, the expansion element may be first located in the second position in the slot and then the annular body is pin punched on opposite sides of the outer edge of the recess. This causes displacement of material over the opening of the recess and this displaced material acts as a retaining lug to hold the expansion element captive in the recess.

Advantageously, the annular body may have at one end a ramp-like profile to define a frustoconical shape or part spherical shaped end surface which is adapted for cooperation with a corresponding configured seat on a washer or workpiece.

The nut is preferably of a steel selected to suit the manufacturing process by which the nut is made, and the manufacturing process may include providing the longitudinal slit with a suitable width, cold pressing the nut to close the slit thereby achieving partial plastic deformation, and removing the pressure, the longitudinal slit recovering in width to have a thickness approximately half of that with which it was originally formed. In this form of the nut the width of the slit is chosen so as to be as small as possible.

However, preferably the nut is manufactured by a process comprising the steps of:

a) providing an annular body having first and second ends extending around an axis with a screw threaded interior passage extending along said axis, said interior passage having a diameter less than the diameter of an intended bolt;

b) milling a cavity in the outer side of the annular body sized to receive an expansion element; and

c) cutting a slit in the annular body, wherein the slit extends outwardly from the interior passage to the outer side of the annular body and axially from the first to the second ends and is arranged to pass through the cavity in the outer side of the annular body. In this process as

well the width of the slit is chosen so as to be as small as possible.

The nut may be of high tensile steel including approximately 0.4% carbon, 0.8% magnesium, 0.9% chromium and 0.2% molybdenum.

In a further aspect the present invention provides a kit of parts comprising:

a) a nut comprising an annular body having first and second ends and extending around an axis with a screw-threaded interior passage extending along said axis, a slit extending outwardly from the interior passage to the outerside of the annular body and extending axially from the first end to the second end, and a recess formed in the annular body and extending to the slit; and

b) an expansion element shaped and dimensioned to be retained in the recess, rotatable therein about a rotation axis between first and second positions,the expansion element being assymetrically shaped about the rotation axis such that movement of the expansion element from the second position to the first position causes the slit to open thereby increasing the diameter of the interior passage of the annular body so that the nut becomes freely rotatable in a bolt on which it is intended to be fitted.

Further embodiments may be developed utilising advances in materials technology and consequently, variations in structure and dimensions may be appropriate.

BRIEF DESCRIPTION OF THE DRAWINGS

Notwithstanding any other forms that may fall within its scope, the preferred forms of the invention will now be described by way of example only with reference to the accompanying drawings in which:

Figure 1 is an elevation of a nut embodying the invention engaged with an intended bolt and associated with a washer (shown in sectional view);

Figure 2 is a reduced plan view of the nut of figure 1;

Figure 3 is an enlarged view showing details of the recess and expansion element of the nut of figure 1;

Figure 4 is an enlarged view showing the expansion element rotated to the first position to open the slit of the nut;

Figure 5 is a cutaway part-perspective view along the slit showing one form of the expansion element engaged with a nut;

Figure 6 illustrates the manner in which one form of the expansion element is engaged with the nut;

Figure 7 illustrates a second embodiment of the invention wherein the expansion element is in a first position and is integral with a lever;

Figure 8 illustrates the nut of figure 7, wherein the expansion element is in the second position;

Figure 9 illustrates an enlarged view showing details of a third embodiment of the nut embodying the invention wherein the expansion element is in the second position; and

Figure 10 is a sectional view along line A-A of the nut of figure 9.

BEST MODES FOR CARRYING OUT THE INVENTION

Referring firstly to figures 1 and 2, there is illustrated a nut 10 which is of substantially conventional shape and which is formed of a material of sufficient resilience to serve as a "stiff nut" as described below. The nut 10 incorporates an annular body 11 having an outer periphery in the shape of a hexagon, and an axial screw-threaded passage 12 extending between a planar first or upper end 13 and a second or lower end 14. The lower end 14 having a substantially frustoconical form with the surface 15 of the lower end 14 forming an angle X to the end plane of approximately 5°. In an alternative arrangements (not shown) the angle X could range between 10° and 60° or both ends of the nut could be of planar form.

A longitudinal slit 16 extends radially through one side of the nut body 11 from the interior passage 12 through

to the outer edge. The slit 16 also extends from the first end 13 to the second end 14.

The nut 10 is of a resiliently expandable form and is arranged to be biased into a normal position as shown in figure 1, by the resilient material from which the nut is made. In the normal position the interior passage 12 has a significantly reduced diameter compared with the diameter of a bolt 21. Consequently, when the nut 10 has been fitted to the bolt 21 and the nut is in the normal position, the nut has a very high resistance to rotation.

In a first embodiment an oval, barrel-shaped expansion element 18 is retained in the nut and is rotatable about an axis extending radially relative to the nut between a first position as shown in figure 4 and a second position as shown in figure 3. The expansion element is captive in a cavity 17 comprising a part oval recesses 19 formed in the respective parts of the body 12 on opposite sides of the slit 16. The oval recesses 19 both extend to the slit 16. The expansion element 18 is oval around and rotatable around a rotation axis extending at right angles to the axis of the bolt. As shown in figure 6, in a cross-sectional view parallel to the axis of rotation of the expansion element, the expansion element is substantially barrel-like in shape having inclined side wall portions 22 and a parallel sided central portion 23. The expansion element is snap-fitted into the cavity 17 and recovery of the annular body retains the element.

The expansion element 18 is provided with a hexagonal cavity 20 which is arranged for engagement by a corresponding tool such as an allen key.

When the tool is used to rotate the expansion element it is moved to the first position as shown in figure 4 and this causes the slit to open against the inherent resilience of the nut. Consequently, there is an increase in diameter of the internal thread of the nut to an extent that enables the nut to be freely threaded onto the intended bolt 21 under hand torque, a step conveniently effected with the

tool removed. The nut 10 can be tightened by hand spanner or other tool such as a pneumatic socket spanner to its desired tension. Then, the tool can be used to rotate the expansion element from the first position to the second position as shown in figure 3, thereby permitting the slit to close under the inherent resilience of the nut body 11 towards its normal position and causing the nut 10 to tightly clamp about the threaded bolt 21.

When it is desired to remove the nut 10, the reverse procedure is adopted with the tool being engaged in the hexagonal cavity 20 and rotated to move back the expansion element to the first position (as shown in figure 4) thereby releasing the clamping force of the nut on the threaded bolt 21.

When the nut 10 is wound down a threaded bolt or the like, it seats on the washer 28 with the surfaces 15 and 27 co-operating to prevent radial outward expansion of the nut 10. The taper of the washer is preferably the same as the taper of the thread of the bolt or nut so that when the expansion element 18 is moved to the first position of figure 4, the nut 10 will move down the nut to further mate with the washer 28 due to the wedging cooperation of the threads on the nut 10 and the bolt.

The size of the slit 16 varies with the size of the intended bolt. For a typical nut of 20 mm size (ie. dimensioned to fit a bolt of threaded diameter 20 mm), the width of the slit when in the unexpanded position is suitably 2.28 mm. Whilst in the expanded position, the slit has width of 2.81 mm. When clamped about a stud or bolt, the width of the slit is 2.57 mm. The nut may suitably be formed of a high tensile steel such as a Grade 8 steel which typically includes 0.4% carbon, 0.8% magnesium, 0.9% chromium and 0.2% molybdenum.

In another typical embodiment, the nut suitable for use in heavy engineering such as the petroleum industry is 2H nut used in various sizes. Before use, the slit would be about 4.69 mm width whilst when expanded, it would be

approximately 5.69 mm wide. When clamped about a bolt or stud, the slit width would reduce to 5.17 mm.

The nut could be formed basically by conventional nut-making technology including the domed end but without the slit 16, and with the threaded bore being, for example, 1 mm in diameter less than a conventional nut of the same size. The slit can be made by any conventional cutting process and the oval centrally placed recess 17 milled out by automatic machines. Heat treatment is then effected typically by a hardening operation from 850 degrees C with a quench e.g. in oil followed by a tempering operation to about 450 degrees C followed by a cooling technique e.g. in air. The resultant nut has a degree of resilience suitable for the present purposes.

Referring now to figures 7 and 8, there is illustrated an alternative embodiment of nut 24 according to the present invention which is similar to the embodiment of figures 1 to 4 and in which like features have been given like numerals. In this embodiment however, a tool 25 is associated with the nut 24, the tool 25 being provided at one end with a portion 26 of similar form to the expansion element 18 except that in this instance the portion 26 is of reduced size so as to enable it to be removably retained within the recess 19. It will thus be apparent that when the tool 25 is rotated between the respective positions shown in figures 7 and 8, the slit 16 will open and close to permit the nut 24 to be engaged with a bolt and be easily rotated about the bolt, and permit the nut 24 to clamp about the bolt respectively. In the non-clamping or first position as shown in figure 7, the tool 25, as illustrated, extends in a direction generally longitudinally of the bolt so as to permit the nut 24 to be freely rotated on the bolt.

A third embodiment of the present invention is illustrated in figures 9 and 10. Again this embodiment is similar to the first embodiment of figures 1 to 4 and like features have been given like numerals. In this embodiment, however, the shape of both the expansion element 18 and recess 19 differs from the first embodiment.

As illustrated in figures 9 and 10, the expansion element 18 is substantially cylindrical in shape having an oval cross section. The element 18 has generally parallel sides except for the edge 26 of the upper end 27 of the element 18 which is chamfered. The cavity 17 is arranged with recesses having parallel sides, and is sized to be slightly larger than the expansion element such that the expansion element can be received in the cavity in the second position without requiring expansion of the slit 16.

Once located in the cavity 17, the expansion element 18 is caused to be held captive therein by pin punching the nut on opposite sides of the outer edge 28 of the recess. By pin punching the outer edge of the nut, material is displaced over the opening of each recess 19 and this displaced material forms retaining lug 29 which are sufficient to maintain the expansion element captive in the cavity 17. By having the upper edges 26 of the expansion element chamfered it ensures that the retaining lugs 29 do not inhibit rotation of the expansion element within the cavity. With this arrangement, the expansion element is held captive within the cavity but is still free to rotate from the second position to the first position wherein the expansion element causes expansion of the slit 16.

Compared with a conventional nut, which is free spining on its bolt, the present nut in any of its embodied forms can have a clamping effect around the bolt thereby spreading the load over a considerable length of screw-threading on the bolt. By contrast when a conventional nut is under tension, dilation tends to occur thereby tending to increase the clearance between the threads on the nut and bolt.

Tests have been made on nuts of approximately 20 mm size. All nuts were Grade 8 high tensile steel hardened from 850 degrees C and oil tempered to varying temperatures. It has been found in destruction tests that the Grade 8 bolts used broke before any failure of the nut. Typically bolt failure occurred at around 240 kN.

The torque required to move a 2 inch self locking nut located on a bolt thread but unexpanded has been found to be about 200 foot pounds, which clearly illustrates that the nut is highly resistant to loosening under vibration. Tests showed that the nut would not move under these conditions.

In many applications the coned end of the nut will be reversed in use and the coned washer not used. A conventional washer and the flat end of the self locking nut is more than strong enough for general use when tightening is done with a conventional spanner. When extended handle spanners and impact wrenches are used it is desirable to reverse the nut and to use it as shown in figure 1 with a coned washer.

At least preferred embodiments of the invention permit the following advantages to be achieved:

(i) The nut can be used many times as it has been found that its necessary characteristics can be preserved despite periods of use, substantial vibration during periods of service, removal and re-application. Obviously the nut cannot safely be used again if it has been damaged or stressed during removal, e.g. due to an excessively corroded exposed bolt.

(ii) In the event that the nut cannot be removed, the nut can be opened up by a chisel hammered into the longitudinal slit there by permitting the nut to be rotated and removed. This nut should then be discarded.

(iii) If by accident the nut is not tightened onto a washer or workpiece but the expansion element is moved to the second position, the nut is unlikely to become loose even when subject to severe vibration because of the clamping forces of the nut on the thread.

(iv) Nuts can be manufactured economically and manufacture can be based on conventional nut production techniques; essentially conventional coned nuts are formed with a smaller diameter thread and then subjected to additional processing steps to provide the requisite slit, the oval recess and the preferred heat treatment is then applied.

Use of the present invention can be advantageous in applying frictional forces over most if not virtually all the portion of the bolt thread within the envelope of the nut body and this is in contrast to known stiff nuts. Furthermore, nuts embodying the present invention may be accepted as effective on bolts which are either slightly oversize or slightly under the nominal design size.

Yet another feature which embodiments of the invention can provide is a nut which does not function in a manner which damages or deforms the thread on either the nut or the bolt.

Since nuts embodying the present invention can be designed to be substantially of conventional shape and dimension but having a slightly less thread diameter conventional spanners may be used with the nuts.

In use where a coned washer is eliminated and replaced with a coned entrance to the bolt hole, the nut and bolt combination is much lighter than a conventional nut, thereby being less costly and taking up less space.

In addition, university tests have shown nuts according to the invention, even when used without coned washers, expand a negligible amount when applied to bolts or studs subjected to load tests above their ultimate strength such that the bolts break. When coned washers are employed, the nuts contract a minimal amount and in all cases bolt failure occurs before the nut yields. Consequently, in all cases the nut has been able to be reused after testing.

It is common practice to have one or two turns of a thread protruding above a nut. However, nuts of the present invention permit the end of a stud or bolt to be positioned flush with the top end of the nut. Such a configuration provides overall a lighter, more acceptable and cost efficient structure. Aircraft design in particular, could adopt this strategy to decrease the overall weight and increase the equivalent extra cargo capabilities.

THE CLAIMS:

1. A nut comprising an annular body having first and second ends extending around an axis with a screw-threaded interior passage extending along said axis and a slit extending outwardly from the interior passage to the outer side of the annular body and extending axially from the first end to the second end, the nut being of resiliently expandable form for fitting to an intended bolt and being biased by the resilient material from which the nut is made into a normal position wherein the interior passage has a significantly reduced diameter compared with the diameter of the intended bolt such that when fitted on the bolt, the nut has a high resistance to rotation, an expansion element being retained in the annular body and being rotatable between a first position wherein the expansion element causes the slit to open against the inherent resilience of the nut to permit the nut to be freely threaded onto the bolt, and a second position wherein the expansion element allows the slit to close under the influence of the inherent resilience of the nut towards or to the normal position such that the nut, when located on the bolt, is caused to clamp tightly on the bolt.

2. A nut as claimed in claim 1, wherein the expansion element incorporates engagement means adapted for engagement with a corresponding tool to facilitate movement of the expansion element between the first and second positions.

3. A nut as claimed in claim 2, wherein the engagement means comprises a multisided cavity.

4. A nut as claimed in either claim 2 or 3 wherein an access aperture intersects with the slit and is of greater width than the slit and is dimensioned for accommodating the corresponding tool.

5. A nut as claimed in any one of claims 2 to 4, wherein the corresponding tool is fixed to the engagement means.

6. A nut as claimed in any one of the preceding claims wherein the expansion element is retained in a cavity formed in the body of the nut, the cavity intersecting with said slit.

7. A nut as claimed in claim 6, wherein the cavity comprises part-oval recesses formed in the body of the nut on opposite sides of the slit.

8. A nut as claimed in either claim 6 or 7, wherein the expansion element is wholly captive within the cavity.

9. A nut as claimed in claim 8, wherein the expansion element, in cross-section view parallel to an axis about which the expansion element is rotated is barrel-like in shape, and adapted to be fitted into the cavity by a snap-fit.

10. A nut as claimed in claim 8, wherein the expansion element is substantially cylindrical in shape having first and second ends interconnected by a continuous wall surface, the expansion element being held captive within the cavity by way of retaining lugs which extend from the annular body over the opening of the cavity, the retaining lugs being located at or adjacent the outer side of the annular body.

11. A nut as claimed in claim 10, wherein the retaining lugs are formed by pin punching the outer side of the annular body at or adjacent the outer edge of the cavity.

12. A nut as claimed in claim 10 or 11, wherein the edge of the first end of the expansion element is chamfered.

13. A nut as claimed in any one of claims 3 to 12, wherein the cavity is located midway between the first and second ends of the annular body.

14. A nut as claimed in any one of the preceding claims, wherein the expansion element is oval in cross sectional view taken at right angles to the axis which the expansion element is rotated.

15. A nut as claimed in any one of the preceding claims, wherein the annular body has at one end a ramp-like profile which is adapted for co-operation with a corresponding configured seat on a washer or workpiece.

16. A nut as claimed in any one of the preceding claims and wherein the nut is of steel selected to suit a manufacturing process by which the nut is made, the manufacturing process including providing the longitudinal slit, cold pressing the nut to close the slit thereby achieving partial plastic deformation, and removing the pressure, the longitudinal slit recovering in width to have a thickness approximately half of that with which it was originally formed.

17. A nut as claimed in any one of claims 6 to 12, wherein the nut is manufactured by the process comprising the steps of:

a) providing an annular body having first and second ends extending around an axis with a screw threaded interior passage extending along said axis, said interior passage having a diameter less than the diameter of an intended bolt;

b) milling a cavity in the outer side of the annular body sized to receive an expansion element therein; and

c) cutting a slit in the annular body, wherein the slit extends outwardly from the interior passage to the outer side of the annular body and axially from the first to the second end and is arranged to pass through the cavity in the outer side of the annular body.

18. A nut as claimed in any one of the preceding claims and wherein said nut is of a high tensile steel including approximately 0.4% carbon, 0.8% magnesium, 0.9% chromium and 0.2% molybdenum.

19. A nut as claimed in any one of the preceding claims and wherein the nut was produced by heat treating the nut with a high temperature initial treatment and a subsequent lower temperature tempering operation to provide a tough and resilient characteristic in the nut.

20. A nut as claimed in claim 19 and wherein said heat treatment included heating to approximately 850°C and cooling, and subsequent re-heating to approximately 450°C and quenching in a tempering operation.

21. A kit of parts comprising:

a) a nut comprising an annular body having first and second ends and extending around an axis with a screw-threaded interior passage extending along said axis, a slit extending outwardly from the interior passage to the outerside of the annular body and extending axially from the first end to the second end, and a recess formed in the annular body and extending to the slit; and

b) an expansion element shaped and dimensioned to be retained in the recess, rotatable therein about a rotation axis between first and second positions,the expansion element being assymetrically shaped about the rotation axis such that movement of the expansion element from the second position to the first position causes the slit to open thereby increasing the diameter of the interior passage of the annular body so that the nut becomes freely rotatable on a bolt on which it is intended to be fitted.

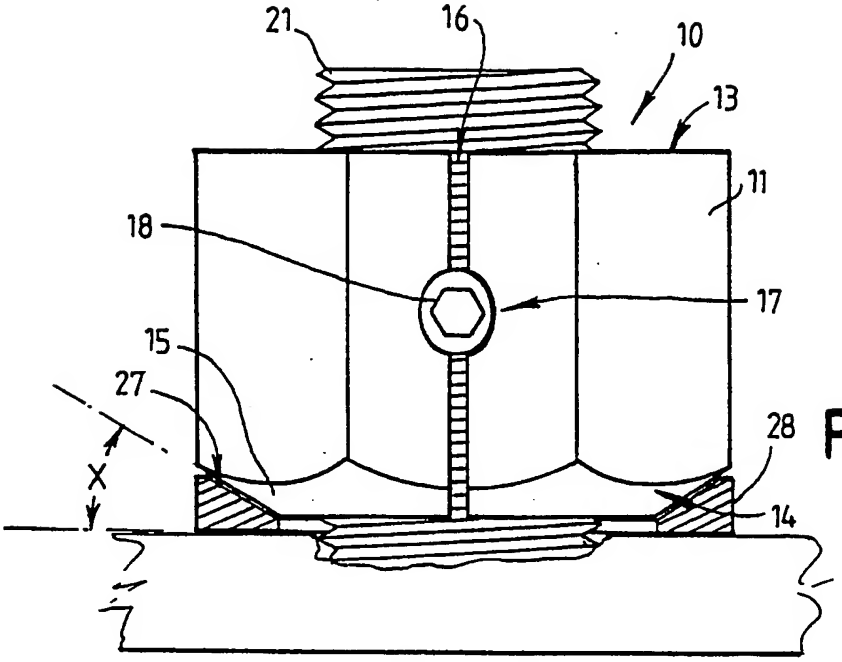


FIG.1

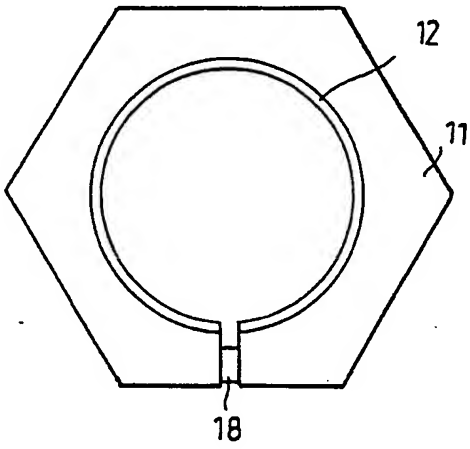


FIG.2

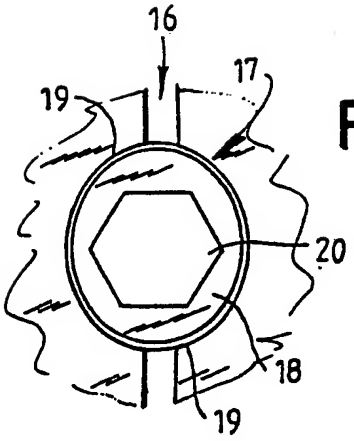


FIG.3

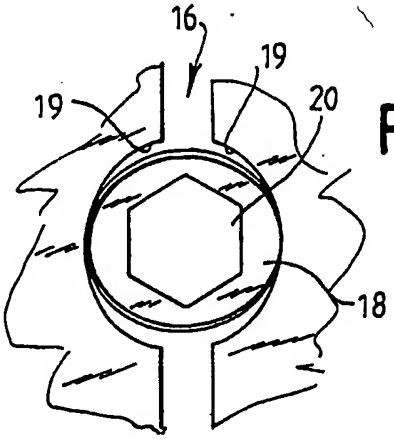


FIG.4

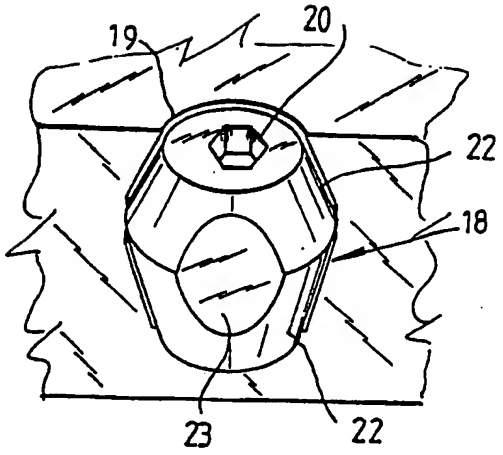


FIG.5

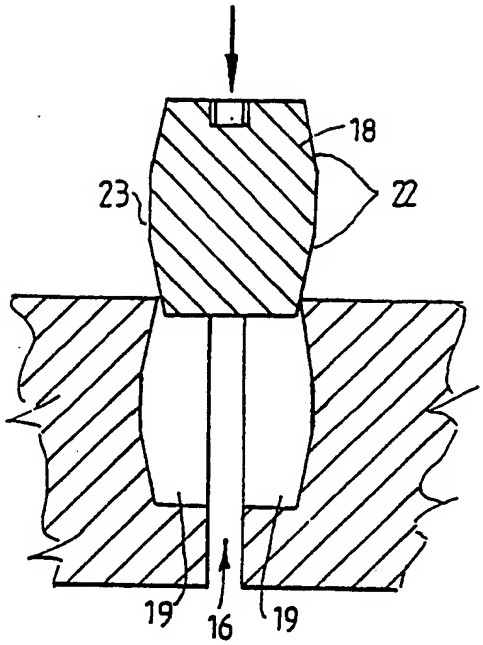


FIG.6

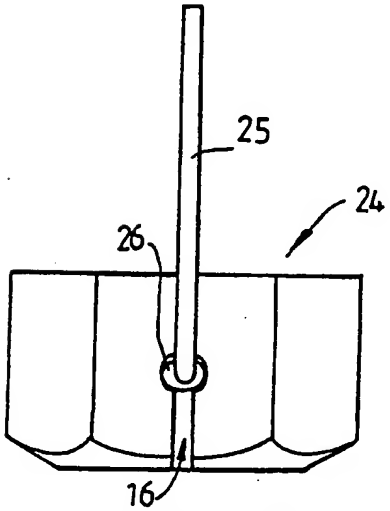


FIG.7

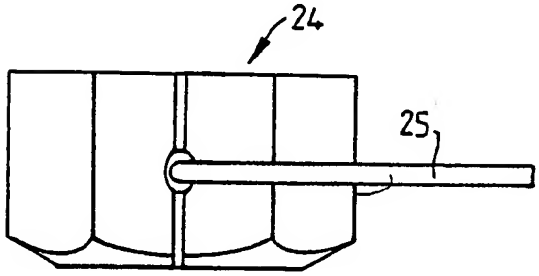


FIG.8

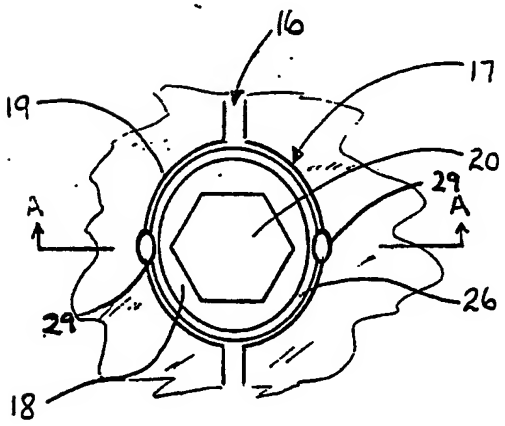


FIG.9

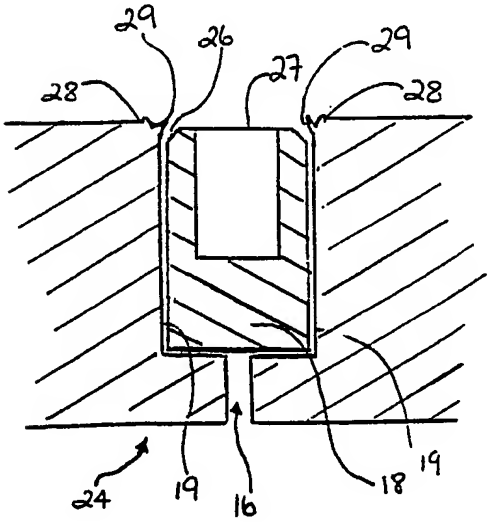


FIG.10

# INTERNATIONAL SEARCH REPORT

International Application No. PCT/AU 90/00317

## I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) 6

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl.[5] F16B 37/10, 39/02

## II. FIELDS SEARCHED

Minimum Documentation Searched 7

| Classification System | Classification Symbols |
|---|---|
| IPC | F16B 37/10, 39/02 |

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched 8

AU: IPC as above

## III. DOCUMENTS CONSIDERED TO BE RELEVANT 9

| Category* | Citation of Document, 11 with indication, where appropriate, of the relevant passages 12 | Relevant to Claim No 13 |
|---|---|---|
| X,Y | US,A, 1852919 (COLAS) 5 April 1932 (05.04.32) (& GB,A, 306033, & FR,A, 663000). See line 60 column 2 to line 27 column 3, lines 39-42 column 3. | (1-9,14-21) |
| X,Y | FR,A, 831922 (COLAS) 16 September 1938 (16.09.38) See entire document. | (1-9,14-21) |
| Y | AU,A, 77884/87 (WILLIAMS) 11 February 1988 (11.02.88) See line 19 page 2 to line 33 page 3. | (1-21) |
| Y | AU,A, 60943/80 (AJAX NETTLEFOLDS LTD) 5 February 1981 (05.02.81) See line 29 page 2 to line 9 page 3. | (1-21) |

* Special categories of cited documents: 10

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

## IV. CERTIFICATION

| Date of the Actual Completion of the International Search | Date of Mailing of this International Search Report |
|---|---|
| 18 September 1990 (18.09.90) | 2 October 1990 |
| International Searching Authority | Signature of Authorized Officer |
| Australian Patent Office | P. WARD |

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON
INTERNATIONAL APPLICATION NO. PCT/AU 90/00317

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

| Patent Document Cited in Search Report | Patent Family Members | | | | | |
|---|---|---|---|---|---|---|
| AU 77884/87 | CN | 87105389 | EP | 276286 | ES | 2008152 |
| | IL | 83396 | NZ | 221244 | PT | 85446 |
| | WO | 8801024 | ZA | 8705644 | | |

END OF ANNEX